Final Year Project Proposal

IOT BASED AIR QUALITY INDEX METER

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Contents

1.INTRODUCTION:

In an era, the integration of IOT environmental monitoring systems, particularly Air quality Index(AQI) systems, is crucial for public health and environmental protection. With Urbanization and industrial activities increasing, real-time, accurate air quality data is essential. IOT based AQI systems enable continuous monitoring of air pollutants, providing timely insights and prompt responses to deteriorating air conditions.

IOT technology connects sensors to measure air pollutants like PM2.5, PM10, CO and NO_2. Data is transferred to a central server for analysis and accessibility. This real-time monitoring helps mitigate poor air quality impacts, shapes policies and raise awareness about maintaining a healthy environment. It also plays a crucial role in shaping policies and raising awareness.

2.PROBLEM STATEMENT:

The primary issue with this project is its lengthy detection range, which prevents it from accurately displaying the city's air quality reading on the sensors. Urbanization and industrialization have led to a decline in air quality, posing health risks and environmental issues. A project aims to develop an IOT-based AQI system to monitor air pollutants in real-time enabling timely interventions and informed decision-making. The project aims to identify key pollutants, analyze their impact on health and the environment and develop a robust system for continuous monitoring. The solution’s business scope includes urban planning, public health management and industrial compliance with primary end-users being environmental agencies, local governments, industries and the general public.

3.LITERATURE REVIEW/BACKGROUND:

IOT-based Air Quality Index(AQI) systems are gaining popularity due to concerns over air pollution and its impact on public health and the environment. These systems use low-cost, portable sensors to provide real-time on pollutants like PM2.5 ,PM10,CO,SO_2 AND NO_2.These sensors are connected via IOT to a central server, which processes and analyzes the data. This approach enhances spatial and temporal resolution of air quality data and facilitates proactive environmental management by providing real-time alerts and insights.

The integration of IOT in air quality data index(AQI) systems has the potential to revolutionize environmental monitoring by democratizing access to air quality data. Predictive data analytics powered by machine learning and cloud computing can improve system effectiveness, enabling early warning systems, informed decision making and public awareness. IOT-based AQI systems play a critical role in urban planning, public health management and industrial compliance, necessitating innovative solutions to combat air pollution.

Table 1:LITERATURE REVIEW OF AIR QUALITY INDEX

STUDY	**AUTHORS**	**YEAR**	**KEY FINDINGS**
Deployment of Low-Cost Sensors	Kumar et al.	2019	The study showcased the efficacy of low-cost, IoT-based sensors in monitoring scalable air quality.
Predictive Analytics in AQI Systems	Smith and Lee	2020	The integration of machine learning for predictive analytics has been highlighted as a method to improve early warning systems.
Real-Time Data for Public Health	Johnson et al.	2021	The use of real-time, IoT-based air quality data has significantly enhanced public health responses.
Enhancing Environmental Awareness	Chen and Patel	2022	The article highlighted the significant role of IoT in enhancing public engagement and raising awareness about air quality issues.

TABLE 2: Literature Review Comparison

Ref #	Published year	Methodology	Results/ Findings	Parameters	Shortcomings/ Gaps
1.	2020	IoT and ML-based smart system for garbage monitoring	Real-time AQI monitoring and fire detection are being implemented for dump yards and garbage management.	Temperature, moisture, light intensity	The application is restricted to garbage management and does not cover general air quality monitoring.
2.	2020	IoT-based environmental quality control system	The method is effective in monitoring environmental pollutants.	Various air pollutants like CO_2, SO_2.	Large-scale deployments often face high costs and complexity.
3.	2020	IoT framework for urban air quality control	The text focuses on efficient air quality management with solutions that are nearly zero.	O_3, NO_x, CO_2.	Limited scalability; issues with sensor calibration.
4.	2020	IoT-based indoor air quality control system	The system allows for real-time monitoring and control	CO_2, VOCs	Indoor only; does not address outdoor air

			of indoor air quality.		quality monitoring
Proposed System	2021	IoT-based system with Arduino and various sensors	The system monitors various pollutants like O3, SO2, CO, and particulate matter, providing data through a cloud-based interface.	O3, SO2, CO, particulate matter.	The deployment is limited and requires further testing for large-scale outdoor environments and long-term data accuracy.
1.	2018	IoT-based pollution monitoring	The system is continuously monitoring pollution levels through the use of multiple sensors.	CO, particulate matter, smoke.	Limited to predefined areas; lacks user interaction via mobile apps
2.	2018	Edge computing-based IoT architecture	The proposed solution aims to reduce cloud dependency by utilizing low-cost monitoring	CO, NOx, VOCs	The edge computing setup is highly complex and not easily scalable.

			methods and local data processing.		
3.	2018	IoT-enabled air pollution monitoring and awareness.	Tracks pollutants and raises public awareness through displays and notifications	CO, NH3, particulate matter, smoke	Limited user customizatio n; lacks predictive analytics for future air quality trends
Proposed System	2023	IoT-enabled air pollution meter with smartphone dashboard	The mobile app offers real-time data and alerts on air quality, including AQI calculations.	CO, NH3, particulate matter, smoke.	The system requires constant internet connection for real-time updates and is restricted to areas with smartphone accessibility. The system requires constant internet connection for real-time updates and is restricted to areas with smartphone accessibility.
1.	2020	IoT-based smart	Detects pollutants	CO, smoke, gas	Data retrieval limited to

		environment monitoring	like CO, smoke, gas; uses LCD for display.		every 8 hours; no IoT integration.
2.	2008	Environment -al air pollution monitoring with IEEE 1451.	Monitors CO, NO2, SO2, O3 using semiconduct or sensors	CO, NO2, SO2, O3	The process necessitates calibration for various gases prior to each measurement
3.	2018	Centralized air pollution detection and monitoring	Uses microcontrol ler and WiFi module; supports various gas sensing methods	Multiple pollutants (method dependent)	Lacks specific IoT feature integration; manual data evaluation.
Proposed System	2022	Real-time indoor/outdo or monitoring with IoT	Uses ESP32, MQ135, DHT22; displays data via BLYNK app	CO2, temperature, humidity	Limited range due to WiFi module; performance dependent on stable network connection.

TABLE 3: Comparison of Proposed system with existing systems

Functionality	Proposed System	Existing System

	Name	System name 1	System name 2	System name 3
Real-time monitoring	Yes	Yes	No	Yes
Data Accuracy	High	Medium	Low	Medium
Ease of use	Yes	No	Yes	No
Security	Yes	No	Yes	No
Alerts and Notification	Multiple Sensors Supported	Single Sensor	Single Sensor	Multiple Sensors Supported
Historical Data Analysis	Yes	No	No	Yes
Cost Efficiency	Moderate	High	Medium	Low
Scalability	High	Low	Medium	High
Maintenance Requirements	Low	High	Medium	Low

4.PROPOSED DESGIN METHODOLGY /FRAMEWORK/ARCHITECTURE:

ABSTRACT DESGIN:

The IOT-based Air Quality Index Meter uses advanced sensors to monitor air quality in real-time. It measures parameters like PM,CO_2 and NO_2 and transmits data via a wireless network to a cloud-based network. The data is analyzed and presented in a user-friendly format, aiming to create an accurate, reliable and user-centric air quality monitoring solution with real-time data visualization and historical analysis.

COMPONENT-LEVEL DESIGN:

The project involves designing sensor modules, microcontrollers and communication interfaces. Sensors will be chosen based on accuracy, range and reliability. The microcontroller unit will handle data acquisition, processing and transmission. Communication interfaces will facilitate seamless data transfer between sensor nodes and the cloud platform. Power management strategies will be incorporated for long-term operation.

SYSTEM REQUIRMENT SPECIFICATIONS(SRS):

The SRS document will outline the functional and non-functional requirements of an air quality index meter, covering accurate pollutant measurement, real-time data transmission and user alerts. It will also cover performances metrics. The SRS will guide development and testing to ensure the system meets all standards and user expectations.

EQUATIONS:

$$\boldsymbol{AQI} = \left[\frac{(\boldsymbol{PMobs-PMmin})*(\boldsymbol{AQImax-AQImin})}{(\boldsymbol{PMmax-PMmin})}\right] + \text{AQImin} \text{->4.1}$$

$$\text{AQI}=\left(\frac{\text{Ci-Clow}}{Chigh-Clow}\right)*(Ihigh-Ilow)+Ilow \text{->4.2}$$

FIGURE:

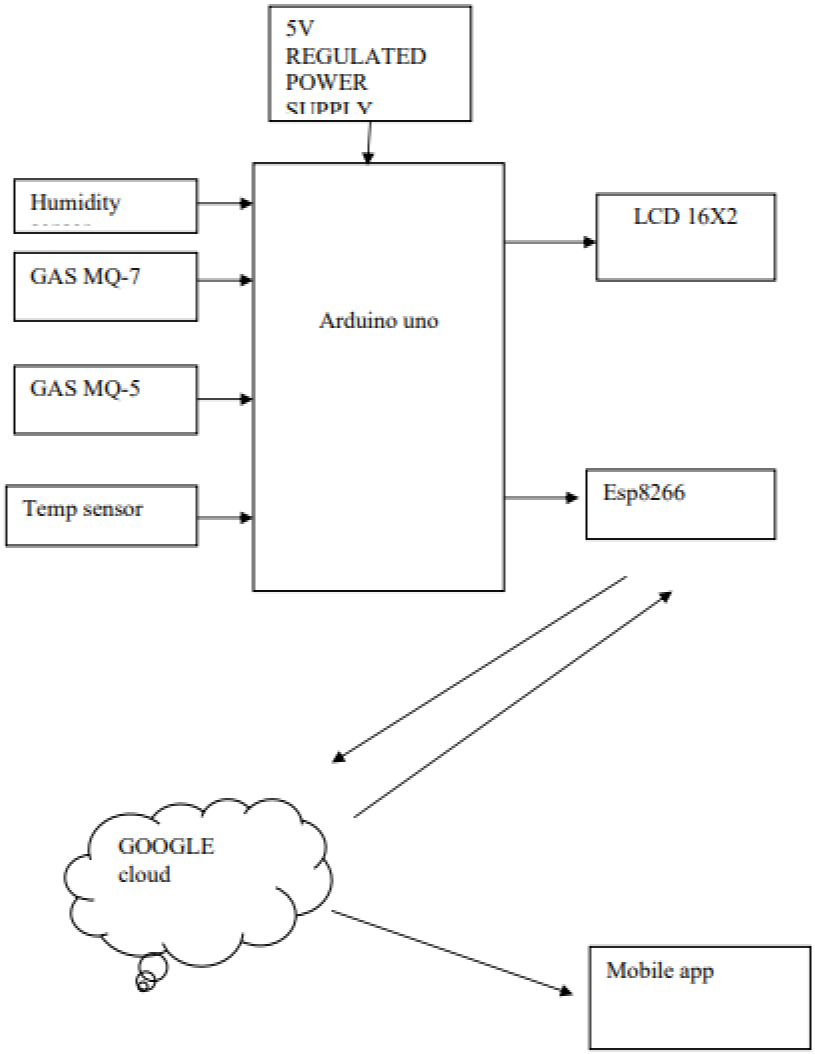


FIGURE 1:BLOCK DIAGRAM OF IOT BASED AQI METER

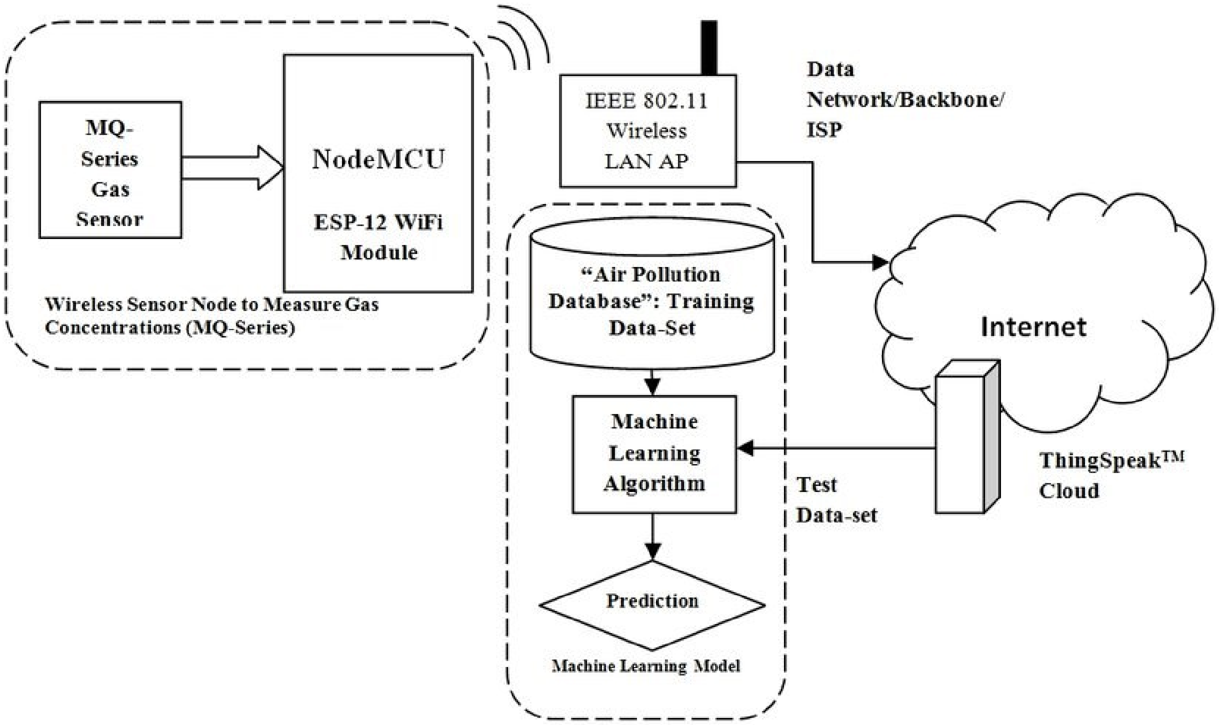


FIGURE 2:PROJECT DIAGRM OF IOT BASED AQI METER

5. HARDWARE/SOFTWARE TOOLS:

HARDWARE TOOLS:

1:ESP32/ESP8266

2:ARDUINO

3:MQ SERIES GAS SENSOR(MQ-135 OR MQ-5)

4:PM2.5 AND PM10 SENSORS

5: BATTERY PACK

6: POWER ADAPTER

7: CHARGER SETUP

8: WEATHERPROOF HOUSING

9: WiFi/BLUETOOTH MODULES

SOFTWARE TOOLS:

1: ANDORID STUDIO

2: FIREBASE

3:BLYNK APP

4:MATLAB

5:PYTHON

6: ARDUINO FRAMEWORK

7:VS CODE FOR FIRMWARE CODING

8: THINGS SPEAK

9:MQTT PROTOCOLS

10: AWS IOT

11:ADAFRUIT IO

12:GITHUB

13: AUTHENTICATION MECHANISMS

14: GAFRANA

15:EXCEL

16:HTTP/HTTPS

17:SENSOR AND WiFi LIBRARIES

Decided to choose the mentioned tools

HARDWARE TOOLS:

1: Is decided to choose the **ESP32/ESP8266** because the microcontrollers with integrated WiFi and Bluetooth are ideal for IoT applications due to their connectivity and processing power.

2:Is decided to choose the **ESP** because of this is a user-friendly microcontroller board designed for prototyping and sensor interfacing.

3: Is decided to choose the **MQ SERIES GAS SENSOR(MQ-135 OR MQ-5)** because the sensors are essential for detecting various gases and are crucial for measuring air quality.

4:Is decided to choose the **PM2.5 AND PM10 SENSORS** because of the purpose of this text is to provide a concise summary on the measurement of particulate matter in the air for the purpose of air quality monitoring.

5:Is decided to choose the **BATTERY PACK** because of supplies power to the device, allowing for both portable and stationary setups.

6:Is decided to choose the **POWER ADAPTER** because of supplies power to the device, allowing for both portable and stationary setups.

7: Is decided to choose the **CHARGING SETUP** because of the proposed charging setup for an IoT-based AQI meter enhances performance, reduces maintenance, and ensures reliable, sustainable, and efficient power management, making it suitable for long-term deployment.

8:This decided to choose the **WEATHERPROOF HOUSING** because of this product safeguards electronic devices from harmful environmental conditions, ensuring their durability in outdoor environments.

9:Is decided to choose the **WiFi/BLUETOOTH MODULES** because of the device facilitates wireless communication between it and other systems.

SOFTWARE TOOLS:

1: Is decided to choose the **ANDORID STUDIO** because of the platform is designed to develop mobile applications that can interact with the AQI meter.

2: Is decided to choose the **FIREBASE** because of provides real-time database and authentication services for managing IoT data and user interactions.

3: Is decided to choose the **BLYNK APP** because of the feature facilitates the creation of IoT interfaces and dashboards on mobile devices with ease.

4: Is decided to choose the **MATLAB** because of this tool is utilized for advanced data analysis and visualization.

5: Is decided to choose the **PYTHON** because of the language is versatile and suitable for scripting, data processing, and API integration.

6: Is decided to choose the **ARDUINO FRAMEWORK** because of the Arduino framework provides a standardized programming environment, simplifying development and ensuring hardware compatibility, and is widely used, well-documented, and easy to find resources and community support.

7: Is decided to choose the **VS CODE FOR FIRMWARE CODING** because Arduino and VS Code are used for ESP32 development, offering flexibility and access to various libraries, enhancing the development process.

8:Is decided to choose the **THINGS SPEAK** because the cloud platform is designed for storing and visualizing IoT data.

9:Is decided to choose the **MQTT PROTOCOLS** because of the lightweight messaging protocol is designed for efficient IoT communication.

10:Is decided to choose the **AWS IOT** because the company offers comprehensive cloud services for managing and processing data related to IoT devices.

11: Is decided to choose the **ADAFRUIT IO** because of the cloud service is designed for effectively managing and visualizing IoT data.

12: Is decided to choose the **GITHUB** because of the platform is designed for version control and collaboration in code development.

13: Is decided to choose the **AUTHENTICATION MECHANISMS** because of the goal is to ensure secure access and communication within the IoT system.

14: Is decided to choose the **GAFRANA** because of this is an advanced tool designed for creating interactive data visualizations and dashboards.

15: Is decided to choose the **EXCEL** because of this is a tool designed for the systematic organization and analysis of data.

16: Is decided to choose the **HTTP/HTTPS** because of this refers to the protocols that ensure secure communication between devices and servers.

17: Is decided to choose the **SENSOR AND WiFi LIBRARIES** because of the task involves creating code and functions for integrating sensors and managing WiFi communication.

6. PROPOSED WORK PLAN:

The proposed IoT-based Air Quality Index (AQI) Meter project proposal includes a Gantt chart for semester-wise workload, broken down into modules and time estimates, ensuring alignment with your requirements.

1. Identify Project Modules/Features/Tasks/Activities:

MODULE 1: Requirement Analysis and Research

i. Research AQI standards and metrics

ii. Define project scope and objectives

iii. Identify required sensors and hardware components

MODULE 2: System Design

i. Hardware design (schematics, selection of sensors, microcontroller, etc.)

ii. Software architecture (flowcharts, data processing algorithms)

iii. Connectivity and network design (WiFi, cloud integration)

MODULE 3: Hardware Assembly and Testing

i. Assembly of sensors and microcontroller (ESP32)

ii. Initial testing of sensor data acquisition

MODULE 4: Software Development

i. Development of firmware for data acquisition and processing

ii. Integration of WiFi and cloud services (MQTT, HTTP, etc.)

iii. Development of the user interface (web or mobile app)

MODULE 5: System Integration and Testing

i. Integration of hardware and software components

ii. Testing for accuracy, data consistency, and reliability

iii. Calibration of sensors to ensure correct AQI readings

MODULE 6: Deployment and Documentation

i. Deployment of the AQI meter in a test environment

ii. Documentation of the entire project, including user manual and technical documentation

iii. Final testing and debugging

2. Time Needed to Implement Each Module/Feature/Task/Activity:

i. Module 1: Requirement Analysis and Research - 2 weeks

ii. Module 2: System Design - 3 weeks

iii. Module 3: Hardware Assembly and Testing - 4 weeks

iv. Module 4: Software Development - 6 weeks

v. Module 5: System Integration and Testing - 4 weeks

vi. Module 6: Deployment and Documentation - 3 weeks

3. Semester-wise Workload Plan:

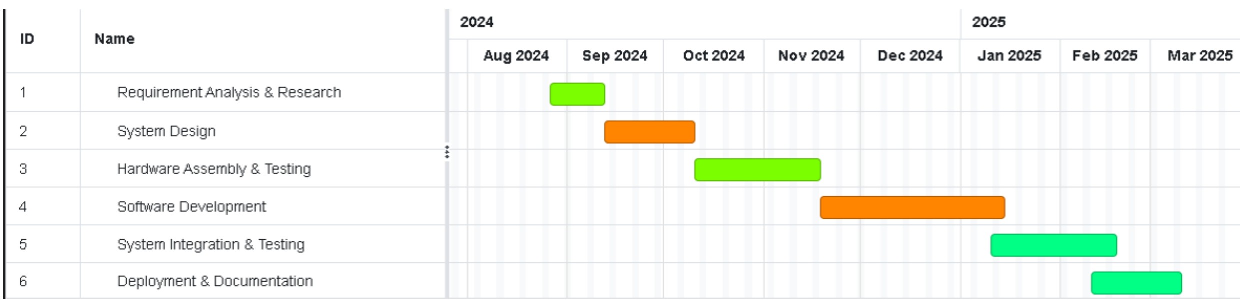
Semester 7:

Focus on Modules 1, 2, and part of Module 3.

Semester 8:

Focus on completing Module 3 and Modules 4, 5, and 6.

4. Gantt Chart for IoT-Based AQI Meter Project:



1:Requirement Analysis & Research

START DATE: 26Aug 2024

FINISH DATE: 12Sep 2024

DURATION:14 days

2: System Design

START DATE: 12Sep 2024

FINISH DATE: 10Oct 2024

DURATION:21 days

3:Hardware Assembly and Testing

START DATE: 10Oct 2024

FINISH DATE:18 Nov 2024

DURATION:28 days

4: Software Development

START DATE: 18 Nov 2024

FINISH DATE:14 Jan2025

DURATION: 42 days

5: System Integration and Testing

START DATE: 14 Jan2025

FINISH DATE:20Feb2025

DURATION:28 days

6: Deployment and Documentation

START DATE: 20Feb2025

FINISH DATE: 20Mar 2025

DURATION:21 days

7.CONCLUSION:

In conclusion, the IoT-based Air Quality Index (AQI) Meter is a cost-effective solution for real-time monitoring of air quality. It collects, analyzes, and displays data, providing insights for proactive pollution mitigation and public health protection. The system integrates sensors, cloud connectivity, and data visualization tools, ensuring accurate readings and informed decision-making. This project could significantly contribute to environmental monitoring and improve quality of life by addressing air pollution challenges.

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22:PYTHON https://www.python.org https://www.anaconda.com

23:ARDUNIO IDE https://www.arduino.cc/en/software/

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9.COLLABORATORS:

RISETECH OF NUST EME COLLEGE

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DR USMAN AKARM

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